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Ohio Engineering Students Create Custom Prosthetic Liners

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CEDARVILLE, OHIO -- It's a problem most of us can relate to — clothing material that scratches our skin or causes uncomfortable chafing. That kind of problem is easily solved by changing clothes. But for an amputee wearing what amounts to a sock over their residual limb, such a dilemma can be painful and demoralizing.

To solve this problem, amputees with irregular amputations typically turn to a custom liner. But the custom prosthetic liner manufacturing process is tedious and time-consuming, usually requiring five to 10 days.

Enter Cedarville University senior mechanical engineering students, who've dedicated their senior capstone project to reducing the manufacturing process time from 10 days to one day in partnership with Optimus Prosthetics (Dayton, Ohio).

The senior mechanical engineers working on this project include Kenneth Coppens (Chambersburg, Pennsylvania); Tad McKanna (Bowling Green, Ohio); Joshua Wells (Williamsburg, Ohio); and Isaac Wheeler (Newark, Ohio). They are guided by faculty advisors Dr. Tim Norman, distinguished professor of mechanical and biomedical engineering, and Jay Kinsinger, associate professor of mechanical and biomedical engineering.

The primary goal of the project is to develop a process that allows prosthetists to create customs liners for amputees that is more efficient than the current custom liner manufacturing process. They plan to complete their project by April 2019.

While most amputees can be fit with a standard prosthetic liner for their residual limb, those with irregular limb shapes require a custom liner to reduce the load on the residual limb. This allows for a longer wear because it prevents irritation from the air bubbles and chaffing caused by putting a standard liner on an irregular amputation.

Laura Klagstad, a certified prosthetist orthotist, and Russell Hawkes, a prosthetic technician who is also an amputee, from Optimus Prosthetics in Dayton, are working with Cedarville's engineering students on this project.

"Gel liners are integral in today's prosthetic fitting process," explained Klagstad. "Custom distal gel cups and custom liners provide an option for these patients to obtain a comfortable fit, however fabrication of these custom devices is timely and expensive. There is also a great deal of variability due to current fabrication practices. We hope to streamline this process through 3D printing for improved patient satisfaction and overall reduction in fabrication complexity and cost."

The two options to meet this objective are 3D printing the liner itself or 3D printing the mold for the liner material to be injected into. The use of a computer numerical control (CNC) machine, stereolithography (SLA) robotics and fused deposition modeling (FDM) are all possible options to manufacture a custom liner or mold.

“This project is a way that we can use our knowledge and manufacturing experience to love others and share our abilities with people who have a need for the things we are developing,” said McKanna, the team leader.

The ideal outcome would be to develop a process that allows for prosthetists to 3D print a custom liner at their office, which would allow for a quicker and more efficient process to create irregularly shaped liners. Throughout this project, both methods will be evaluated and the best process will be determined.

“It is a thrill as an engineer to see the direct and immediate benefits that a project has on a client,” explained Kinsinger. “Twenty-five years ago an amputee’s only option for a liner was a woolen sock. The creation of polymer gel liners was revolutionary. These students are now revolutionizing the revolutionary.”

Located in southwest Ohio, Cedarville University is an accredited, Christ-centered, Baptist institution with an enrollment of 4,193 undergraduate, graduate, and online students in more than 150 areas of study. Founded in 1887, Cedarville is recognized nationally for its authentic Christian community, rigorous academic programs, strong graduation and retention rates, accredited professional and health science offerings, and leading student satisfaction ratings. For more information about the University, visit www.cedarville.edu.